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State Severance Taxes: A Summary and an Analysis of the Impact of Rate Changes on Copper Recovery Costs

By Phillip N. Yasnowsky and Annette P. Graham

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR
James G. Watt, Secretary

BUREAU OF MINES
Robert C. Horton, Director

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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STATE SEVERANCE TAXES: A SUMMARY AND AN ANALYSIS OF THE IMPACT OF RATE CHANGES ON COPPER RECOVERY COSTS

By Phillip N. Yasnowsky[1] and Annette P. Graham[1]

ABSTRACT

This Bureau of Mines report summarizes State severance taxes imposed on minerals and mineral fuels, provides a hypothetical example of how a State severance tax affects selected components of a firm's income statement, and uses the Bureau's Minerals Availability System (MAS) to estimate the effect of assumed changes in State severance tax rates on copper recovery cost at given levels of potential copper availability. A reduction of the rates to zero or a doubling of them results in changes in costs that are of the same order of magnitude as the cost of transporting copper to the United States from major foreign producing countries.

INTRODUCTION

This Bureau of Mines report provides information and analyses regarding State severance taxes on minerals. Severance taxes may be levied on the "severing" of any natural resource such as minerals, timber, or fish. However, severance taxes on minerals are of special interest because they are the most important in dollar terms and also in frequency of application. Although the tax system of an individual State is the prerogative of that State, State taxes affect the mineral industries and mineral supplies; therefore, they are of interest to the Bureau of Mines. Only the overall or general effects of severance taxes are analyzed in this paper; an analysis of individual State severance taxes is not undertaken.

This report is an update and expansion of work done previously by the authors (10-11).[2] For a comprehensive background study of severance taxes, the reader is referred to Information Circular 8788 (6). The Bureau of Mines Minerals Availability System (2, 5, 9) is used to analyze the possible effect of severance taxes on copper recovery costs.

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[2]Underlined numbers in parentheses refer to items in the list of references at the end of this report.

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SUMMARY OF STATE SEVERANCE TAXES

Severance taxes have been defined as "taxes imposed distinctively on removal of natural products--that is, oil, gas, other minerals, timber, fish, etc.--from land or water and measured by value or quantity of products removed or sold" (8). These taxes are generally levied by the State governments.

Currently 33 States impose severance taxes on minerals. Table 1 lists the States and summarizes their severance taxes on minerals as of July 1, 1981. State statutes or appropriate summaries of statutes should be consulted if greater detail is needed. For severance tax use, various States apply unique definitions to terms such as gross value, market value, or taxable value. For example, the New Mexico Severance Tax Law defines gross value for potash as "33-1/3% of proceeds realized from the sale of potash products requiring processing or beneficiation and 33-1/3% of the value of potash products consumed in producing other potash products, less 50% of such value as a deduction for expenses" (1).

Generally severance taxes are levied on a physical unit or value basis. The choice of a physical unit or value basis may be of considerable importance during periods of price changes. Some States recognize this when setting rates. For example, Minnesota and North Dakota tie some physical-unit-based taxes to price indexes. The number of States using each or both bases of taxation is as follows:

Basis	Number of States
Unit and value.....	17
Value only.....	11
Unit only.....	5

The bases of individual taxes differ among States, making comparison of tax rates difficult. Generally, the rates based on gross value range from 2% to 30%. On a physical unit basis, oil is subject to rates ranging from less than 1¢/bbl to 80¢/bbl. The rates on natural gas are from less than 1¢ to 12.6¢ per 1,000 cubic feet. For the nonfuel minerals, rates based on physical units are from 0.5¢/ton on salt in brine used for manufacturing (Louisiana) to $1.67/ton for phosphate rock in Florida.

Of the States with severance taxes on minerals, 16 States have broad-based taxes in the sense that they cover a wide range of minerals. The imposition of a severance tax does not necessarily mean that a mineral is currently produced in a State. For example, both Georgia and North Carolina tax oil and gas; however, there is no production of these fuels within these States at present.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981

State and commodity	Tax	Rate and basis
Alabama:		
Iron ore	Iron ore mining	3¢/ton.
Oil and gas	Oil and gas production	2% of gross value.
Oil, gas, and other hydrocarbons.	Oil and gas severance.	6% of gross value (4% for new wells for 10 years).
Coal	Coal severance	13.5¢/ton.
Coal and lignite	Coal and lignite severance.	20¢/ton.
Alaska:		
Oil	Oil and gas production.	15% of gross value (12.25% for new wells for 5 years) or 80¢/bbl (greater amount).
Gas	....do....	10% of gross value or 6.4¢/1,000 cu ft (greater amount).
Oil	Regulation and conservation.	0.125¢/bbl.
Arizona: All minerals	Transaction privilege..	2.5% of gross income.
Arkansas:		
Barite, bauxite, titanium ore, manganese and manganiferous ores, zinc ore, cinnabar, and lead ore.	Natural resources severance.	15¢/ton.
Coal, lignite, and iron ore	....do....	2¢/ton.
Gypsum (sold for use out of State), chemical-grade limestone, silica sand, and dimension stone.	....do....	1.5¢/ton.
Crushed stone, including chert, granite, slate, novaculite, limestone, construction sand, gravel, clay, chalk, shale, marl.	....do....	1¢/ton.
Brine	....do....	30¢/1,000 bbl.
Salt water used as raw material for bromine.	....do....	$2/1,000 bbl.
Oil	....do....	4% of market value if producing 10 bbl/day or less plus 2.5¢/bbl. 5% of market value if producing more than 10 bbl/day plus 2.5¢/bbl.
Gas	....do....	0.3¢/1,000 cu ft.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Arkansas - continued		
Diamond, fuller's earth, ochre, natural asphalt, native sulfur, salt, pearls, other precious stones, whetstone, novaculite, all other natural resources except gypsum.	Natural resources severance.	5% of market value.
Oil	Oil and gas conservation	Not to exceed 2.5¢/bbl.
Gas	.....do.....	Not to exceed 0.5¢/1,000 cu ft.
California: Oil and gas...	Oil and gas production..	Rate determined annually by Department of Conservation. The bases are barrels and cubic feet.
Colorado:		
Oil and gas	Oil and gas conservation	Not to exceed 0.1¢/$1 of market value.
Coal	Severance	60¢/ton plus a price index adjustment.
Metallic minerals (except molybdenum).	.....do.....	2.25% of gross income over $11 million.
Molybdenum ore	.....do.....	15¢/ton.
Oil and gas	.....do.....	2% of gross income (g.i.) under $25,000. 3% from $25,000 and under $100,000 g.i. 4% from $100,000 and under $300,000 g.i. 5% when g.i. exceeds $300,000.
Oil shale	.....do.....	4% of gross proceeds.
Connecticut	No mineral severance tax	
Delaware	.....do.....	
Florida:		
Oil	Oil and gas production.	8% of gross value.
Escaped oil	.....do.....	20.5% of gross value.
Gas	.....do.....	5% of gross value.
Solid minerals (except phosphate rock and heavy minerals).	Solid minerals.....	5% of market value.
Phosphate rock	.....do.....	$1.67/ton plus a price index adjustment.
Heavy minerals	.....do.....	84¢/ton plus a price index adjustment.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Georgia:		
Oil	Oil and gas production.	0.5¢/bbl.
Gas	....do....	0.05¢/1,000 cu ft.
Hawaii: All minerals	General excise	0.5% of gross proceeds.
Idaho:		
Ores	Ore severance	2% of net value.
Oil	Oil and gas production.	Determined annually, but not to exceed 0.5¢/bbl.
Gas	....do....	Determined annually, but not to exceed 0.5¢/50,000 cu ft.
Oil and gas	Additional oil and gas production.	2% of market value.
Illinois	No mineral severance tax.	
Indiana: Oil, gas and other hydrocarbons.	Petroleum production	1% of value.
Iowa	No mineral severance tax.	
Kansas:		
Oil	Oil and gas production	0.4¢/bbl.
Gas	....do....	0.085¢/1,000 cu ft.
Kentucky:		
Oil	Oil production	4.5% of market value.
Coal	Coal severance	4.5% of gross value (minimum of 50¢/ton).
All minerals (except coal and oil).	Natural resource severance.	4.5% of gross value.
Louisiana:		
Oil	Natural resources severance.	12.5% of value.
Gas	....do....	1.3¢ to 7¢/1,000 cu ft.
Distillate, condensate, or similar natural resources severed with oil or gas.	....do....	12.5% of value.
Natural gasoline, casinghead gasoline and other natural gas liquids, ethane or methane recovered through processing gas after separation of oil, distillate, or similar natural resources.	....do....	10¢/bbl.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Louisiana - continued		
Butane and propane recovered through processing gas after separation of oil.	Natural resources severance.	5¢/bbl.
Coal	.....do.....	10¢/ton.
Gravel	.....do.....	3¢/ton.
Marble	.....do.....	20¢/ton.
Ores	.....do.....	10¢/ton.
Salt	.....do.....	6¢/ton.
Salt content in brine used for manufacturing.	.....do.....	0.5¢/ton.
Sand	.....do.....	3¢/ton.
Shells	.....do.....	4¢/ton.
Stone	.....do.....	3¢/ton.
Sulfur	.....do.....	$1.03/long ton.
Maine	No mineral severance tax.	
Maryland	.....do.....	
Massachusetts	.....do.....	
Michigan:		
Gas	Gas and oil severance.	5% of market value plus fee not to exceed 1% of previous year's value.
Oil	.....do.....	6.6% of market value plus fee not to exceed 1% of previous year's value.
Minnesota:		
Taconite, semitaconite, and iron sulfides.	Iron severance.....	15% of value (minus certain costs).
Other iron ore	.....do.....	15.5% of value (minus certain costs).
Taconite, semitaconite, and iron sulfides.	Ore royalty.....	15% of royalty received.
Other iron ores	.....do.....	15.5% of royalty received.
Taconite and iron sulfides.	Taconite, iron sulfides, and agglomerate.	$1.25/long ton merchantable iron ore concentrate (5¢/long ton for agglomerates) plus factors based on iron content and a price index.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Minnesota - Continued		
Semitaconite.....	Semitaconite.....	10¢/ton of merchantable concentrate (5¢/ton if agglomerated in State) plus factor based on iron content.
Copper-nickel ores.....	Occupation.....	1% of value.
Do.....	Mining, quarrying, and production of concentrates.	2.5¢/long ton plus factor based on content.
Do.....	Ore royalty.....	1% of royalties plus 1% of royalties paid on gold, silver, platinum, and other precious metals.
Mississippi:		
Oil.....	Oil and gas severance....	6¢/bbl or 6% of value (greater amount).
Oil.....	Oil and gas board maintenance.	0.8¢/bbl.
Gas (including casinghead gas).	Oil and gas severance....	0.3¢/1,000 cu ft or 6% of value (greater amount).
Do.....	Oil and gas board maintenance.	0.08¢/1,000 cu ft.
Salt.....	Salt severance.....	3% of value of production.
Missouri.....	No minerals severance tax.	
Montana:		
Coal.....	Coal severance.....	Applies to production greater than 5,000 tons/quarter as follows:
Note: For both surface and underground, use the basis (per ton or value) that provides the greater yield.	Surface.....	7,000 or less Btu/lb, 12¢/ton or 20% of value. More than 7,000 to 8,000 Btu/lb, 22¢/ton or 30% of value. More than 8,000 to 9,000 Btu/lb, 34¢/ton or 30% of value. More than 9,000 Btu/lb, 40¢/ton or 30% of value.
	Underground.....	7,000 or less Btu/lb, 5¢/ton or 3% of value. More than 7,000 to 8,000 Btu/lb, 8¢/ton or 4% of value. More than 8,000 to 9,000 Btu/lb, 10¢/ton or 4% of value. More than 9,000 Btu/lb, 12¢/ton or 4% of value.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Montana - continued		
Metals, precious or semiprecious gems or stones.	Metalliferous mines license.	0.15% of gross value (g.v.) on first $100,000. 0.575% on g.v. exceeding $100,000 to $250,000. 0.86% on g.v. exceeding $250,000 to $400,000. 1.15% on g.v. exceeding $400,000 to $500,000. 1.438% on g.v. exceeding $500,000.
Oil and gas.....	Oil and gas producers' severance.	Oil 5% and gas 2.65% of gross value.
Do.....	Oil and gas severance....	0.05% of market value.
Perlite, vermiculite, kerrite, maconite, or other micaceous minerals.	Micaceous minerals license.	5¢/ton.
All minerals.....	Mineral mining.....	0.5% of gross value over $5,000 plus $25.
Nebraska:		
Oil and gas.....	Oil and gas severance....	3% of value.
Do.....	Oil and gas conservation.	0.1¢/$1 of value.
Nevada:		
All minerals.....	Net proceeds of mines....	Property tax rate of mine location applied to net proceeds.
Oil.....	Oil and gas conservation.	0.5¢/bbl.
Gas.....	.....do.....	0.5¢/50,000 cu ft.
New Hampshire.....	No mineral severance tax.	
New Jersey.....	.....do.....	
New Mexico:		
General (excluding oil, gas, other liquid hydrocarbons, and carbon dioxide).	Resources excise.....	Natural resources subject to either resources or processors' or service tax.
Potash.....	Resources.....	0.5% of taxable value.
Do.....	Processors' or service...	0.125% of taxable value.
Molybdenum.....	.....do.....	Do.
Other taxable resources.	.....do.....	0.75% of taxable value.
Copper.....	Severance.....	0.5% of gross value.
Potash.....	.....do.....	2.5% of gross value.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
New Mexico - continued		
Gold, lead, silver, zinc, molybdenum, manganese, thorium, rare earth and other metals.	Severance.....	0.125% of gross value.
Clay, gravel, gypsum, sand, pumice, and other nonmetals.	.....do.....	Do.
Coal.....	.....do.....	82.6¢/ton plus a price index adjustment.
Uranium.....	.....do.....	Rates per pound of U_3O_8 range from 2% for taxable value of $5 or less to $3.15 plus 12.5% of excess over $40 for taxable value of $40 or more.
Oil and other liquid hydrocarbons.	Oil and gas severance....	3.75% of taxable value.
Gas.....	.....do.....	12.6¢/1,000 cu ft.
Carbon dioxide.....	.....do.....	3.75% of taxable value.
Oil, gas, liquid hydrocarbons, and carbon dioxide.	Oil and gas privilege....	2.55% of value.
Do.....	Oil and gas ad valorem production.	Rate certified to Oil and Gas Accounting Division.
Oil, gas, liquid hydrocarbons, geothermal energy and carbon dioxide, coal and uranium.	Oil and gas conservation.	0.19% of value.
Gas and hydrocarbons incidental to processing.	Natural gas processors..	0.45% of value.
New York.....	No mineral severance tax.	
North Carolina:		
Oil.....	Oil and gas conservation.	May not exceed 0.5¢/bbl.
Gas.....	.....do.....	May not exceed 0.05¢/1,000 cu ft.
North Dakota:		
Oil and gas.....	Oil and gas production...	5% of gross value.
Coal.....	Coal severance.....	85¢/ton plus increase based on a price index.
Oil.....	Oil extraction.....	6.5% of gross value.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Ohio:		
Coal and salt	Resource severance	4¢/ton.
Limestone and dolomite	...do	1¢/ton.
Sand and gravel	...do	1¢/ton.
Oil	...do	3¢/bbl.
Gas	...do	1¢/1,000 cu ft.
Oklahoma:		
Asphalt, ores bearing lead, zinc, jack, gold, silver, and copper.	Oil, gas, and mineral gross production.	0.75% of gross value.
Oil or other crude or mineral oils, natural and casinghead gas.	...do	7.085% of gross value.
Uranium	...do	5% of gross value.
Gas (natural and/or casinghead).	Natural gas and casinghead gas conservation excise.	7¢/1,000 cu ft of gas produced and saved, less 7% of gross value.
Coal	Coal production	5¢/ton.
Oregon	No mineral severance tax.	
Pennsylvania	...do	
Rhode Island	...do	
South Carolina	...do	
South Dakota:		
Energy minerals	Energy minerals severance	4.5% of taxable value.
Gold and silver	Precious metals severance.	6% of total receipts.
Tennessee:		
Oil and gas	Oil and gas severance	1.5% of sales price.
Coal	Coal severance	20¢/ton.
Texas:		
Oil	Oil production	4.6% of market value plus 0.1875¢/bbl.
Gas	Natural gas production	7.5% of market value.
Sulfur	Sulfur production	$1.03/long ton.
Utah:		
Gold, silver, copper, lead, iron, zinc, tungsten, uranium, or other valuable metal.	Mining occupation	1% of gross value.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Utah - continued		
Oil, gas, and other hydrocarbons.	Mining occupation.....	2% of gross value.
Oil and gas.....	Oil and gas conservation.	0.15¢/$1 of market value.
Vermont.....	No mineral severance tax.	
Virginia.....	.....do.....	
Washington: All minerals..	Business and occupation..	0.44% of value.
West Virginia:		
Limestone or sandstone, quarried or mined.	Occupational gross income.	2.2% of gross proceeds of production (g.p.p.).
Mineral products not quarried or mined.	.....do.....	4.34% of g.p.p.
Coal.....	.....do.....	3.85% of g.p.p.
Oil.....	.....do.....	4.34% of g.p.p.
Natural gas.....	.....do.....	8.63% of g.p.p. if over $5,000.
Other minerals.....	.....do.....	2.86% of g.p.p.
Wisconsin: Metalliferous minerals.	Metalliferous minerals occupation.	6% when average net proceeds (a.n.p.) in preceding 3 years are $100,001 to $4,000,000. 12% when a.n.p. are $4,000,001 to $10,000,000. 16% when a.n.p. are $10,000,001 to $20,000,000. 18% when a.n.p. are $20,000,001 to $30,000,000. 20% when a.n.p. exceed $30,000,000.
Wyoming:		
Oil and gas.....	Oil and gas production...	0.06¢/$1 of value.
Trona and uranium.....	Mining excise and severance.	5.5% of gross value (g.v.).
Oil, natural gas.....	.....do.....	6% of g.v.
Oil shale and other fossil fuels (except coal, oil, gas).	.....do.....	4% of g.v.

TABLE 1. - Summary of State severance taxes on mineral production as of July 1, 1981--Continued

State and commodity	Tax	Rate and basis
Wyoming - continued		
Coal.....	Mining excise and severance.	10.5% of g.v.
Other minerals.....	.....do.....	2% of g.v.

NOTE. -- This summary of mineral severance taxes is comprehensive in that an effort has been made to include all State taxes that specify some sort of unique treatment with regard to mineral production. Therefore, some State taxes included here may not be considered severance taxes in other compilations.

Source: Commerce Clearing House, Inc. State Tax Guide: All States. New York, Chicago, and Washington, 1980 (with updated supplements).

HYPOTHETICAL ILLUSTRATION OF THE STATE SEVERANCE TAX ON MINERALS--IMPACT ON CASH FLOW

A major concern of mining operations subject to State severance taxes is their negative impact on cash flow.[3] The following is a simplified, hypothetical illustration of how the severance tax at various rates affects cash flow. The components of cash flow used are the standard, basic ones used by most businesses. The addition of the percentage depletion allowance amount to cash flow is unique for those businesses engaged in mining. Other types of businesses may have more or fewer components of cash flow, depending on their operations.

Depreciation, depletion, amortization, and deferred deductions are "book deductions" for tax purposes, and these deductions correspond to actual expenditures only by coincidence (7). These "book deductions" and net profit are available to be reinvested by the owners of a business. Net profit plus the aforementioned noncash expenditures make up the cash flow of a business.

The impact of the State severance tax at various rates is presented in a hypothetical case in table 2. The abbreviated income statement in table 2 shows the effects of severance taxes of 2.5% to 30% (of gross income from mining) on cash flow. It should be pointed out that this illustration does not take into consideration any exemptions, credits, or other special provisions provided by most States to businesses subject to the tax. Additionally, the Federal corporate income tax rate is the highest rate used currently.

Cash flow represents the true inflow and outflow of purchasing power for the business. Any expense requiring a cash outlay reduces earnings. Severance taxes, like State income taxes and other taxes on income, require cash outlays. For Federal income tax purposes these expenses reduce taxable income in the year that they are paid. Despite this seemingly positive aspect of the severance tax as an expense item, table 2 shows that the impact on cash flow for our hypothetical business is a negative one. With expenses (except those listed separately), depreciation and percentage depletion remaining at the same levels (for severance tax rates of 2.5% to 20%), it can be seen that the impact of the severance tax is to lower net income, a component of cash flow. Cash flow decreases from $410 million with a zero severance tax to $304 million with a 20% severance tax. At the 2.5% rate cash flow is 97% of the zero severance tax amount. Cash flow drops significantly to 74% of the zero severance tax amount when a 20% rate is applied.

The difficulties inherent in trying to isolate and analyze the impact of one tax are brought into focus with the application of the 30% tax rate. The severance tax of $296 million generated by this rate acts to reduce income before depletion and Federal income tax to a level such that the 50% limitation for percentage depletion comes into play. Under the other five cases the allowable percentage depletion is $148 million. With a 30% severance tax rate, the income on which percentage depletion is calculated is reduced such that the amount allowed under the 50% limitation is only $124 million.

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[3]Cash flow is the after-tax money that remains available to a company or an individual to pay off its debts and invest in new projects from sales revenue after paying all of its operating expenses and income taxes (7).

TABLE 2. - Hypothetical illustration of the use of the State severance tax on a nonfuel mineral

(Million dollars)

	Assume no severance tax	Assume 2.5% rate	Assume 5.0% rate	Assume 10% rate	Assume 20% rate	Assume 30% rate
Gross income from mining.....	987	987	987	987	987	987
Expenses (except those listed separately below)	(395)	(395)	(395)	(395)	(395)	(395)
Income before depreciation, depletion and taxes.....	592	592	592	592	592	592
Depreciation.....	(49)	(49)	(49)	(49)	(49)	(49)
Percentage depletion allowance 1/	(148)	(148)	(148)	(148)	(148)	2/(124)
State severance tax.....	0	(25)	(49)	(99)	(197)	(296)
Income before taxes.....	395	370	346	296	198	123
Federal income tax (rate 46%) 3/...	(182)	(170)	(159)	(136)	(91)	(57)
Net income.....	213	200	187	160	107	66
Cash flow:						
Net income.....	213	200	187	160	107	66
Depreciation....	49	49	49	49	49	49
Depletion.....	148	148	148	148	148	124
Total.....	410	397	384	357	304	239

NOTE. - Parentheses indicate enclosed figure is to be subtracted to obtain following entry; e.g., gross income from mining minus expenses = income before depreciation, depletion, and taxes.

1/ Percentage depletion allowance calculated at 15% of gross income not to exceed 50% of taxable income calculated before the percentage depletion allowance deduction.

2/ 50% taxable income limit for percentage depletion allowance is used.

3/ Currently the highest statutory rate for corporate income tax.

ESTIMATED EFFECT OF SEVERANCE TAX RATE CHANGES ON COPPER RECOVERY COSTS

Methodology

This study uses the Bureau of Mines Minerals Availability System (MAS) to estimate the effect of assumed changes in State severance tax rates on copper recovery costs at given levels of domestic copper availability. Availability is used here to mean the same thing as production. The following two paragraphs provide a brief and simplified explanation of the MAS, which is described in detail elsewhere (2, 5, 9).

The MAS is a Bureau system for determining potential mineral availability by identifying and then performing cost evaluations on major mineral deposits. The Supply Analysis Model (SAM), which uses the discounted cash flow rate-of-return method, contains the financial analysis component of the MAS. The domestic copper part of the MAS consists of the 73 properties shown below, which are also the properties used in the subsequent analysis. The analysis also considers separately the 34 producing and the 39 nonproducing properties (status as of January 1980).

Producing	Nonproducing
Arizona:	Alaska:
1. Bagdad	1. Arctic Camp
2. Bluebird	2. Bond Creek, Orange Hill
3. Christmas	3. Bornite
4. Cyprus Johnson Camp	4. Brady Glacier
5. Esperanza	5. Yakobi Island
6. Inspiration Area	Arizona:
7. Lakeshore	6. Casa Grande
8. Magma (Superior)	7. Copper Basin
9. Metcalf	8. Dubacher Canyon
10. Miami Leach	9. Florence Conoco
11. Mineral Park	10. Helvetia East
12. Mission San Xavier	11. Helvetia West
13. Morenci	12. Miami East
14. New Cornelia (Ajo)	13. Oracle Ridge
15. Ox Hide	14. Palo Verde
16. Pima	15. Peacock
17. Pinto Valley	16. Red Mountain
18. Ray	17. Safford Inspiration
19. Sacaton	18. Safford Kennecott
20. San Manuel-Kalamazoo	19. Safford Phelps Dodge
21. Sierrita	20. Van Dyke
22. Silver Bell	21. Vekol Hills
23. Twin Buttes	California:
Michigan:	22. Lights Creek
24. White Pine	23. Walker
Montana:	Michigan:
25. Butte	24. Presque Isle
Nevada:	Minnesota:
26. New Ruth	25. Minnamax
27. Victoria	26. Ely Spruce
28. Yerrington	

Producing	Nonproducing
New Mexico:	Montana:
29. Chino	27. Heddleston
30. Continental--Underground	28. Stillwater
31. Continental--Surface	29. Troy
32. Tyrone	Nevada:
Tennessee:	30. Hall
33. Copperhill	New Mexico:
Utah:	31. Hillsboro (Copper Flat)
34. Bingham	32. Nacimiento
	33. Pinos Altos
	Utah:
	34. Carr Fork[1]
	Washington:
	35. Sunrise
	Wisconsin:
	36. Crandon
	37. Flambeau
	38. Pelican River
	Wyoming:
	39. Kirwin

[1]A producing property starting in October 1979.

Domestic copper availability is determined by first performing a discounted cash flow rate-of-return analysis using January 1980 costs for each property in the desired group. Then the 73 (or 34 or 39 as the case may be) properties are ranked on the basis of the cost per unit of output required to bring them into operation. The amount of copper potentially available annually or in total is derived from the data for the individual properties. The increases in availability occur in a stepwise fashion in unequal increments with increased costs because the properties generally differ in the amount of copper available from them. Because this ranking of the properties to determine copper availability is done on the basis of cost, some nonproducing properties may be phased in prior to some producers.

The sensitivity of copper recovery costs to changes in severance tax rates was estimated by assuming four cases of rates: (1) Base case, which holds severance taxes at current levels, (2) all severance tax rates reduced to zero, (3) all severance tax rates doubled, and (4) all severance tax rates quadrupled. No changes were made in the taxes of States not utilizing severance taxes, nor were any changes made in the bases of the severance taxes. The following tabulation shows which of the States where the 73 copper properties are located levy severance taxes on copper:

With Severance Taxes		Without Severance Taxes
Arizona	Utah	Alaska
Minnesota	Washington	California
Montana	Wisconsin	Michigan
Nevada	Wyoming	Tennessee
New Mexico		

The assumed cases, which are fairly extreme, are merely used to give an indication of the impact of severance taxes on copper recovery costs and should not be considered realistic. Furthermore, it is not likely that all States with

severance taxes would act in such a concerted fashion as is assumed here. However, there have been some major changes in severance taxes affecting copper in recent years; for example, in Wisconsin (1). Also, legislation that would have raised a severance tax rate from 1.4% to 30% for surface and 15% for underground mines was recently considered in Montana (3). In Arizona, the severance tax on copper was reduced from 2.5% to 2.0% from June 1, 1978, to June 30, 1980, to help alleviate industry difficulties (1).

There are several final points to be made in this discussion of the methodology:

1. It is assumed that the effect of the tax is solely on cost, and that there is no shifting of the tax forward to the consumer. This is probably realistic because copper is traded in world markets and individual producers do not have control over the price. In essence, statutory incidence is the same as economic incidence.

2. The time period necessary to bring the properties into operation is not considered. Lead time is an important factor in determining minerals availability, and its omission here should be kept in mind. The SAM does have the capability for handling lead time, but it is not used in this report.

3. The analysis here is on a property or project basis. In actuality, decisions to invest and bring mineral properties into operation are much more complex than is indicated in this paper. Individual companies, some with business pursuits in addition to mining, must make their decisions to invest on the basis of their own analyses of any given situation.

4. The cost figures in this paper include a 15% rate of return on invested capital.

Results of Analysis

Table 3 shows the estimated effect of assumed severance tax rate changes on copper recovery costs for all of the 73 domestic properties listed above. Annual recoverable copper is shown ranging from 500,000 to 2.5 million metric tons in increments of 500,000 tons. The maximum annual recoverable copper from all 73 domestic properties under the given conditions is 2.7 million metric tons. Total recoverable copper is shown ranging from 20 million to 60 million metric tons in increments of 10 million tons. The maximum total recoverable amounts to 69 million metric tons. In 1979, the quantity of copper actually recovered from domestic mines was 1,444,000 metric tons.

As shown in table 3, the assumed changes in State severance tax rates from current levels cause changes in copper recovery costs ranging from -6¢ to 12¢ per pound for the given levels of annual copper availability. The first 500,000 metric tons of copper would be available at the same recovery cost regardless of which severance tax case is assumed. However, a considerable change in recovery cost occurs when the given level of copper availability is increased to 1 million metric tons annually. Reducing severance tax rates to zero results in a reduction in recovery cost of 6¢ (8.2%) per pound, and doubling the rates increases recovery cost by 6¢ (8.2%). The results become more mixed at higher levels of copper availability, depending on the severance tax case. For example, at a given level of copper availability of 1.5 million metric tons, a zero level of severance taxes reduces recovery cost by only 1¢ (1.1%) per pound, but doubling the tax rate increases the cost by 7¢ (7.9%). The assumed changes in severance tax rates affect the recovery cost of copper from domestic properties in a generally mixed fashion for reasons mentioned following the discussions of tables 4 and 5.

TABLE 3. - Effect of assumed severance tax rate changes on copper recovery cost at given levels of potential availability, domestic properties 1/

Copper availability, million metric tons 2/	Assumed severance tax case								
	Severance tax rates reduced to 0			Severance tax rates at current level, cost per lb	Severance tax rates doubled			Severance tax rates quadrupled		
	Cost per lb	Change from current level			Cost per lb	Change from current level		Cost per lb	Change from current level	
		Per lb	Pct			Per lb	Pct		Per lb	Pct
Annual recoverable:										
0.5	$0.50	0	0.0	$0.50	$0.50	0	0.0	$0.50	0	0.0
1	.67	$-.06	-8.2	.73	.79	$.06	8.2	.80	$.07	9.6
1.5	.88	-.01	-1.1	.89	.96	.07	7.9	1.00	.11	12.4
2	1.21	-.04	-3.2	1.25	1.28	.03	2.4	1.37	.12	9.6
2.5	1.69	-.04	-2.3	1.73	1.77	.04	2.3	1.85	.12	6.9
Total recoverable:										
20	.62	-.02	-3.1	.64	.65	.01	1.6	.70	.06	9.4
30	.83	-.02	-2.4	.85	.88	.03	3.5	.95	.10	11.8
40	.97	-.01	-1.0	.98	.98	0	0	1.04	.06	6.1
50	1.21	-.04	-3.2	1.25	1.28	.03	2.4	1.37	.12	9.6
60	1.57	-.05	-3.1	1.62	1.67	.05	3.1	1.83	.21	13.0

1/ Cost includes a 15-percent rate of return on invested capital. Domestic properties include all of the 73 properties listed in the text.

2/ Maximum annual recoverable copper is 2.7 million metric tons, and maximum total recoverable copper is 69 million metric tons.

Table 4 shows the estimated effect of assumed severance tax rate changes on copper recovery costs for the 34 producing domestic properties. Annual recoverable copper is shown ranging from 250,000 to 1.5 million metric tons in increments of 250,000 tons. The maximum annual recoverable copper from these 34 producing properties is 1.6 million metric tons. Total recoverable copper is shown in amounts ranging from 10 million to 40 million metric tons in increments of 10 million tons. The maximum total recoverable copper from these properties is 44 million metric tons.

As shown in table 4, there is no obvious pattern in the percentage changes in copper recovery costs of producing properties due to the different severance tax cases or as levels of availability are changed. For example, reducing severance taxes to zero reduces recovery costs by 2¢ (2.3%) at an annual copper availability level of 1 million metric tons. This reduction in cost is 1¢ (1.0%) and 3¢ (2.5%) at annual copper availability levels of 1.25 million and 1.5 million metric tons, respectively.

Table 5 shows the estimated effect of assumed severance tax rate changes on copper recovery costs for the 39 nonproducing domestic properties. Annual recoverable copper is shown ranging from 250,000 to 1 million metric tons in increments of 250,000 tons. The maximum quantity of copper potentially available annually from the nonproducing properties is 1.1 million metric tons. Total recoverable copper is given in a range from 5 million to 20 million metric tons in increments of 5 million tons. The maximum total recoverable amount of copper from nonproducing domestic properties is 25 million metric tons.

As in tables 3 and 4, the data for changes in recovery cost in table 5 do not exhibit any particular pattern. The severance tax rate level does have a considerable impact on the recovery costs of the first increment of copper potentially available from nonproducing properties. For the first 250,000 metric tons, reducing severance tax rates to zero decreases the recovery cost by 7¢ (9.5%), and doubling the rates increases this cost by 9¢ (12.2%). The relative effect at subsequent levels of availability is more moderate.

As noted in the methodology section above, the 73 (or 34 or 39) properties are ranked according to per-unit cost, and a given level of availability is reached by adding up the quantities available from individual properties. The cost figure at a given level of availability is the cost required to bring into operation sufficient properties to attain that level. Only the last (or last few) properties will have that cost figure; the others will have lower costs per unit.

The severance tax rate changes affect not only the per-unit recovery costs, but also the order in which the properties are ranked. Only the properties located in the States currently imposing severance taxes will have recovery costs affected by the rate changes. For example, assume State X has a severance tax of 5% and State Y does not impose one. At current rate levels, a property in State Y might be phased in prior to a property in State X. However, if severance tax rates are reduced to zero, the property in State X may then be phased in first. Furthermore, the quantities available from individual properties, on either an annual or a total basis, differ. Therefore, a change in ranking may also lead to a change in the number of properties required to reach a given level of availability. As an illustration, when considering all 73 domestic properties, it takes 23 properties to achieve an annual level of copper availability of 1 million metric tons, assuming severance tax rates at current levels. If severance tax rates are reduced to zero, it takes only 21 properties to reach 1 million metric tons.

TABLE 4. - Effect of assumed severance tax rate changes on copper recovery cost at given levels of potential availability, producing domestic properties 1/

Copper availability, million metric tons 2/	Assumed severance tax case								
	Severance tax rates reduced to 0			Severance tax rates at current level, cost per lb	Severance tax rates doubled			Severance tax rates quadrupled		
	Cost per lb	Change from current level			Cost per lb	Change from current level		Cost per lb	Change from current level	
		Per lb	Pct			Per lb	Pct		Per lb	Pct
Annual recoverable:										
0.25	$0.14	$-0.01	-6.7	$0.15	$0.15	0	0.0	$0.17	$0.02	13.3
.5	.56	-.02	-3.4	.58	.60	$.02	3.4	.64	.06	10.3
.75	.70	-.03	-4.1	.73	.78	.05	6.8	.80	.07	9.6
1.0	.84	-.02	-2.3	.86	.88	.02	2.3	.93	.07	8.1
1.25	.97	-.01	-1.0	.98	.98	0	.0	1.00	.02	2.0
1.5	1.17	-.03	-2.5	1.20	1.23	.03	2.5	1.30	.10	8.3
Total recoverable:										
10	.14	-.01	-6.7	.15	.15	0	.0	.17	.02	13.3
20	.78	-.01	-1.3	.79	.79	0	.0	.80	.01	1.3
30	.88	0	.0	.88	.89	.01	1.1	.95	.07	8.0
40	1.21	-.04	-3.2	1.25	1.28	.03	2.4	1.37	.12	9.6

1/ Cost includes a 15-percent rate of return on invested capital. Producing domestic properties are the 34 producing properties listed in the text.

2/ Maximum annual recoverable copper is 1.6 million metric tons, and maximum total recoverable copper is 44 million metric tons.

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TABLE 5. - Effect of assumed severance tax rate changes on copper recovery cost at given levels of potential availability, nonproducing domestic properties 1/

Copper availability, million metric tons 2/	Assumed severance tax case								
	Severance tax rates reduced to 0			Severance tax rates at current level, cost per lb	Severance tax rates doubled			Severance tax rates quadrupled		
	Cost per lb	Change from current level			Cost per lb	Change from current level		Cost per lb	Change from current level	
		Per lb	Pct			Per lb	Pct		Per lb	Pct
Annual recoverable:										
0.25	$0.67	$-0.07	-9.5	$0.74	$0.83	$0.09	12.2	$0.99	$0.25	33.8
.5	1.31	-.03	-2.2	1.34	1.37	.03	2.2	1.44	.10	7.5
.75	1.57	-.05	-3.1	1.62	1.67	.05	3.1	1.83	.21	13.0
1.0	1.83	0	.0	1.83	1.83	0	.0	2.19	.36	19.7
Total recoverable:										
5	.67	-.07	-9.5	.74	.96	.22	29.7	.99	.25	33.8
10	1.15	-.02	-1.7	1.17	1.20	.03	2.6	1.40	.23	19.7
15	1.38	-.03	-2.1	1.41	1.45	.04	2.8	1.55	.14	9.9
20	1.71	-.04	-2.3	1.75	1.79	.04	2.3	1.89	.14	8.0

1/ Cost includes a 15-percent rate of return on invested capital. Nonproducing domestic properties are the 39 nonproducing properties listed in the text.

2/ Maximum annual recoverable copper is 1.1 million metric tons, and maximum total recoverable copper is 25 million metric tons.

Significance of Results

Given the relatively extreme assumed tax changes, the resultant changes in recovery costs are not particularly significant in an absolute sense. This is partly because not all of the States included in the analysis levy severance taxes, and in those that do, the rates applied are generally relatively low. Also, the effect of the severance tax is lessened owing to its deductibility in computing the Federal income tax. Of course, the effect on any individual operation could be significant.

The changes in recovery cost per pound of copper, ranging from -6¢ to 7¢ for the "all properties" cases of zero severance tax rates and a doubling of the rates, (table 3), need to be placed in perspective to determine some sort of relative significance. The competitiveness of the U.S. mineral industries in world markets has been of concern in recent years. Therefore, an appropriate measure against which to judge the significance of these cost changes would be transportation costs.

It has been observed that "most metals and minerals are international commodities in that only a few cents per pound can move them physically in the major markets of the world" (4). Certainly copper is one of these "international commodities." The following is a sample of ocean liner rates (excluding bunker fuel surcharges) that existed in March 1980:

--Less than 4¢ per pound for Chilean and Peruvian copper bars to U.S. Atlantic and gulf coast ports.

--Between 2¢ and 5¢ per pound for copper concentrates from South America, Africa, and the Far East.

These transportation cost figures are of the same general magnitude as the changes in the copper recovery cost figures caused by the assumed changes in severance tax rates. Of course, as noted earlier, it is not likely that all States would make such changes in severance tax rates. However, major changes in severance taxes on copper, which could be due to changes in the rates or bases of present taxes or the imposition of new ones, could have a comparable effect on the tax burden of copper producers. Also, these results are more significant when it is remembered that the severance tax is only one of the taxes levied on copper producers.

CONCLUSION

Currently 33 States levy severance taxes on minerals. Most States use a value base as opposed to a physical unit base; however, a few States use price indexes to adjust the rate on unit based taxes. Only 16 States have broad-based severance taxes that cover a range of minerals.

The 73 domestic copper properties in the Bureau of Mines Minerals Availability System have been used to estimate the effects of assumed changes in severance tax rates on copper recovery costs. The changes in recovery costs are small given the relatively extreme assumed changes in severance tax rates. However, these results are not insignificant because the severance tax is only a small part of the total tax burden on copper producers. Furthermore, a reduction of the rates to zero or a doubling of them results in changes in costs that are of the same order of magnitude as the cost of transporting copper to the United States from major foreign producing countries.

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